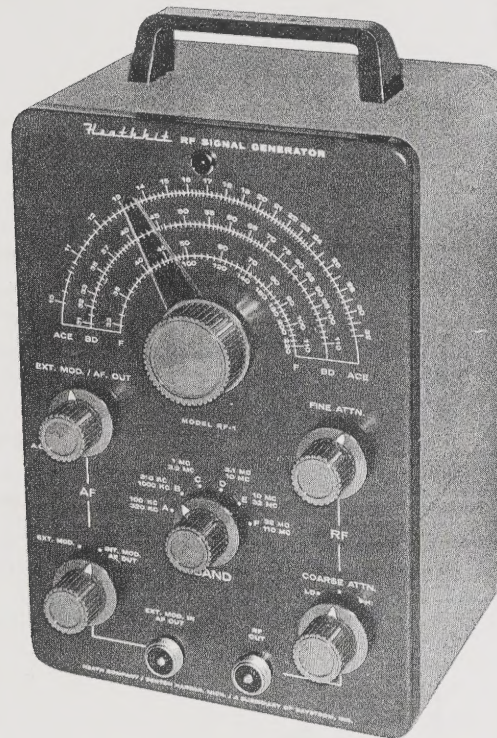




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ASSEMBLY AND OPERATION OF THE HEATHKIT RF SIGNAL GENERATOR MODEL RF-1



SPECIFICATIONS

Frequency Range:

Band A:.....	100 kc to 320 kc.
Band B:.....	310 kc to 1100 kc.
Band C:.....	1 mc to 3.2 mc.
Band D:.....	3.1 mc to 11 mc.
Band E:.....	10 mc to 32 mc.
Band F:.....	32 mc to 110 mc.
Calibrated Harmonics:.....	100 mc to 220 mc.

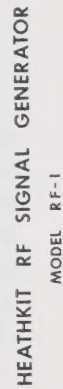
Accuracy:..... 2%.

Output:

Impedance:.....	50 Ω .
Voltage:.....	In excess of 100,000 μ v on all bands.

Modulation:

Internal:.....	400 cycle, approximately 30% depth.
External:.....	Approximately 3 volts across 50 K Ω for 30%.



400 Cycle Audio Output:..... Approximately 10 volts open circuit.

Tube Complement:..... V1 - 12AT7 - RF oscillator.
V2 - 6AN8 - modulator and RF output.

Power Requirements:..... 105-125 volts 50/60 cycle AC 15 watts.

Aluminum Cabinet Dimensions:..... 6 1/2" wide x 9 1/2" high x 5" deep.

Net Weight:..... 4 1/2 lbs.

Shipping Weight:..... 7 lbs.

INTRODUCTION

The Heathkit RF (radio frequency) Signal Generator Model RF-1 has been designed to provide the service technician, ham and experimenter, with an accurate and stable source of RF signals. A preassembled band switch and coil assembly, aligned to factory precision standards, eliminates the necessity of having costly equipment to calibrate the finished kit. To insure that the maximum performance that is available in this kit be realized, it is suggested that the builder take a few minutes now to read the CIRCUIT DESCRIPTION and CONSTRUCTION NOTES.

CIRCUIT DESCRIPTION

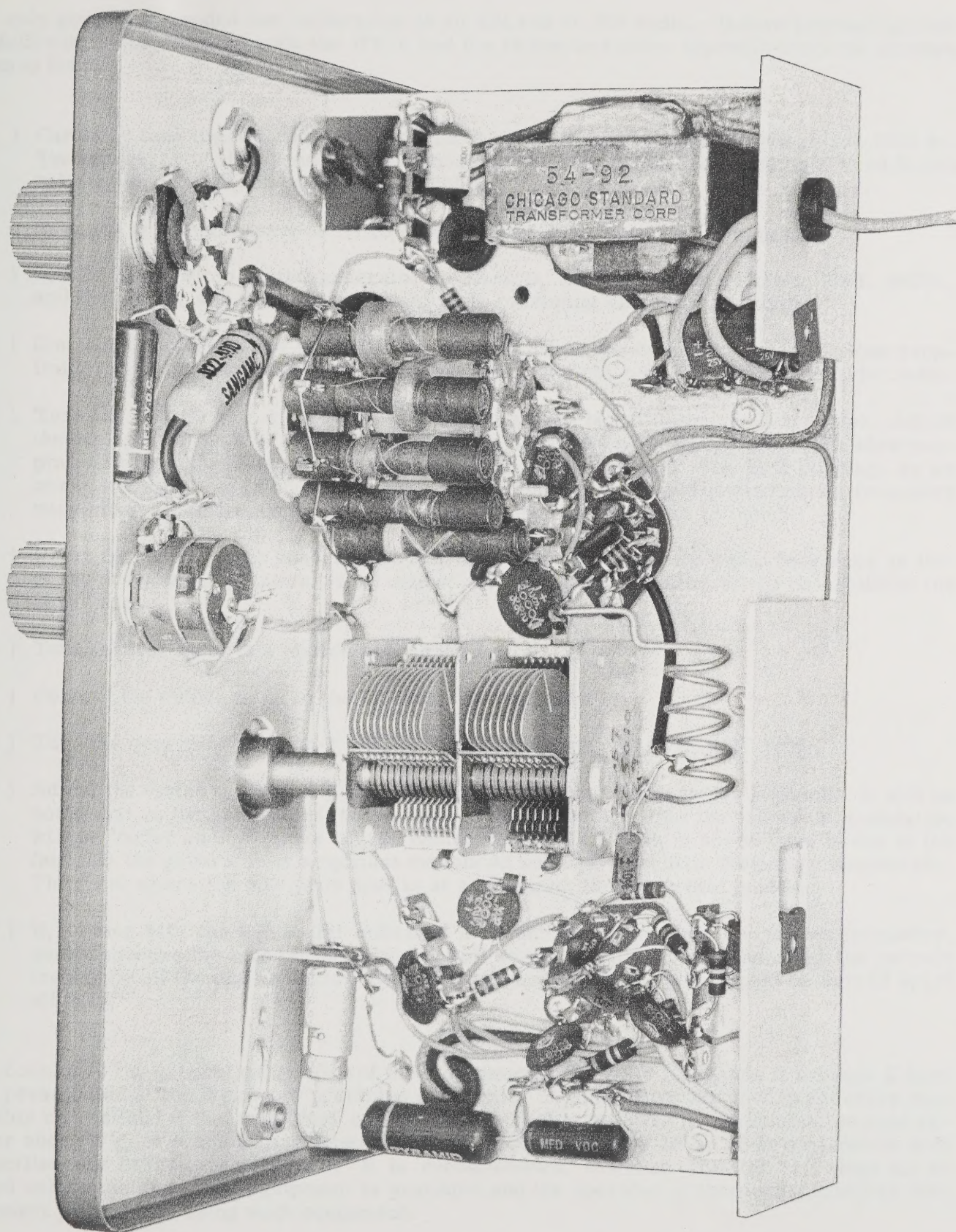
The RF oscillator for Bands A, B, C, D and E consists of one-half of a 12AT7 tube (V1B), the tuning capacitor C12 and the five adjustable Hartley oscillator coils. These coils are supplied as a pre-aligned band switch assembly (SW2). The cathode of the tube is connected to the tap of the coils through switch SW2-BR. Because one end of each coil is grounded, the current from the cathode will excite the coil at resonance. The feedback necessary to maintain oscillation is coupled from the "hot" end of the coil through switch SW2-AF and then through capacitor C8 to the tube grid. Switch SW2-AR shorts out the unused coils to prevent any undesirable suckouts.

The coil for Band F is mounted directly on the tuning capacitor and is permanently connected to the other half of the 12AT7 oscillator tube (V1A). This arrangement eliminates the stray capacities that would be involved in switching and thus provides a more desirable LC ratio. Band switching is accomplished by switching the B+ to Band F through switch SW2-BF.

The triode of a 6AN8 (V2A) is used for the 400 cycle oscillator. A Hartley Oscillator is also used in this circuit but, of course, the coil or reactor is of the iron core type because of the frequency involved. The modulation in-out switch SW3 connects either the plate or the grid through control R6 to the modulation jack. This arrangement enables the 400 cycle output to be amplitude controlled, and also controls the level of external modulation applied to the grid of V2A.

RF signals are coupled to the grid of the 6AN8 output tube (V2B) through capacitors C4 and C11. Modulation is coupled to the grid through capacitor C5, resistors R8 and R9. These components, along with resistor R10, establish the modulation level. The modulated RF signal is then coupled from the plate of V2B through capacitor C25, fine attenuator R13 and the step attenuator switch SW4 to the RF output jack.

The power for the RF-1 is supplied through transformer T1. A conservatively rated silicon diode (D1) is used in a half-wave rectifier circuit to supply the B+ for the generator.



CALIBRATING THE RF-1

The only equipment needed for calibration is an AM and an FM radio. Before proceeding with the following steps, turn on both the RF-1 and the radios and allow approximately ten minutes warmup time.

1. () Carefully tune the AM radio to a station of known frequency between 800 kc and 1000 kc. The frequency of the chosen station should preferably be one that falls on a Band B dial calibration point, such as 850 kc or 1000 kc.
2. () Turn the trimmer capacitor C7 to approximately the center of its range.
3. () Set the band switch of the generator to Band B, the modulation switch to EXT. MOD., and the coarse and fine attenuators to their maximum clockwise rotation.
4. () Connect the output cable to the RF output jack. Place the end of the cable in close proximity to the loop or antenna lead of the radio, but not directly connected to the radio.
5. () Turn the tuning control of the RF-1 until a squeal is heard in the radio receiver. Adjust the tuning for the lowest pitched squeal, or preferably a point where there is a slow popping, with an increasing squeal on either side of this setting. The slow popping, or its complete cessation, is known as "zero beat". The pointer should now indicate a frequency very close to the frequency of the station to which the receiver is tuned.
6. () Reset the tuning of the generator so that the pointer indicates the same frequency as that of the broadcasting station. Now adjust the trimmer capacitor C7 to re-establish the zero beat.
7. () Tune the FM radio to a station around 90 mc.
8. () Connect the output cable to the FM antenna terminals.
9. () Turn the generator to Band F and turn the modulation switch to INT. MOD.
10. () Adjust the tuning of the RF-1 to the frequency to which the receiver is tuned. It will be noted that as the generator is tuned through the frequency, that the 400 cycle modulation will be louder on both sides of the center frequency. This is normal and is due to the fact that the generator is amplitude modulated and has very little frequency modulation. The point where the 400 cycle tone is at a minimum is the correct position.
11. () If, in Step #10, the RF-1 dial indicated a frequency lower than the station frequency, gently squeeze the turns of the Band F coil together until the dial indicates the correct frequency. If the dial indicates a higher frequency, the coil turns should be spread apart slightly.

This concludes the general calibration of the instrument. The coils for Bands A through E have been preadjusted at the factory to precision standards. A slight improvement in accuracy may possibly be realized if the individual coil slugs are tuned, utilizing a communication type receiver and WWV, or a laboratory generator with an accuracy of at least 1% in conjunction with an oscilloscope to indicate zero beat. It is recommended, however, that the coil slugs not be turned unless the preceding equipment is available and the operator is thoroughly familiar with alignment procedures using such equipment.

ACCURACY

Any signal generator is designed as a convenient and controlled source of modulated, or unmodulated, signals. No ordinary signal generator is designed as a frequency standard. Expensive standard signal generators have very accurate (3% to 20%) attenuators which control the output voltage. The frequency calibration accuracy is rarely closer than 1%. The Heathkit RF-1 Signal Generator may be expected to fall within 2% of the dial calibration, which is quite satisfactory for service work and alignment. In receiver adjustment the frequency at which the particular adjustment is made is not very critical, but the adjustment itself for maximum signal output from the receiver is frequently quite critical. For accurate calibration of home-built receivers or equipment, proceed as follows: Make a rough calibration with a signal generator, then with a receiver tune in WWV (Bureau of Standards) at 2.5 mc, 5 mc or 10 mc. Set the generator to a suitable subharmonic such as 500 kc or 1000 kc, then adjust the generator for zero beat. Now, harmonics of the signal generator occur every 500 kc or 1 mc, and these harmonics may be used to give accurate calibration at points 500 kc or 1000 kc apart, such as 2500 kc or 3000 kc. These known frequency points can be marked on the dial of the equipment being calibrated. The object of the rough calibration is merely to furnish a means of identifying, for example, the 3000 kc point from the 2500 kc point, or 3500 kc point. For calibration of higher frequency equipment, a choice of higher reference frequency will reduce the confusion between the multitude of harmonics and will also insure adequate signal strength. When checking the calibration accuracy of the RF-1, the most convenient standards of comparison of sufficient accuracy are broadcast and FM stations of known frequencies. Do not depend on the receiver dial calibrations, however, because they are usually not of sufficient accuracy to warrant consideration.

IN CASE OF DIFFICULTY

1. Recheck the wiring. Trace each lead in colored pencil on the pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the constructor.
2. It is interesting to note that about 90% of the kits that are returned for repair are defective due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as illustrated in the Figures found in the SOLDERING TECHNIQUES section of this manual.
3. Check to be sure that all tubes are in their proper locations. Make sure that all tubes light up properly.
4. Check the values of the component parts. Be sure that the proper part has been wired into the circuit, as shown in the pictorial diagram and as called out in the wiring instructions.
5. Check for bits of solder, wire ends or other foreign matter which may be lodged in the wiring, tube sockets or terminal strips.
6. Check the tubes with a tube tester or by substituting a known good tube of the same type.
7. If, after careful checks, the trouble is still not located and a voltmeter is available, check voltage readings against those found on the Schematic Diagram. NOTE: All voltage readings were taken with a Heathkit Vacuum Tube Voltmeter. Voltages may vary 10% due to line voltage variations.
8. A review of the circuit description will prove helpful in indicating where to look for trouble.
9. If the RF-1 fails to function on any one particular band, the coil for that band may be open.

USING THE RF-1

In order to realize the maximum usefulness of this instrument, the operator should thoroughly familiarize himself with the following information on panel markings, operating procedures, alignment, etc.

The six bands of the RF-1 are calibrated on three large dial scales, rather than six separate scales. This arrangement permits the use of larger lettering and radius on the scales, thereby increasing readability and accuracy. Bands A, C and E are on the first scale, which is calibrated from 10 to 32. On Band A it is necessary to multiply the number by 10, just as is done on many radio dials. For example, if the band switch was on Band A and the pointer at 23 (see Figure 13), the frequency would be 230 kc. On Band C, it is necessary to divide by 10. In other words, 23 on Band C is 2.3 mc. Band E is read directly. Bands B and D are on another scale. On Band B, you must multiply by 10. Therefore, 75 would be 750 kc. On Band D, the number must be divided by 10, thus making 75 equal 7.5 mc. Band F is a separate scale and can be read directly. Another feature of the dial scales is the special markings at 10.7 mc and 455 kc. These are the most commonly used IF frequencies for FM and AM radios, respectively.

The RF fine attenuator, coarse attenuator and RF output are self explanatory. 400 cycle audio frequency is available at the EXT MOD IN/AF OUT jack, when the modulation switch is in the internal modulation position. When the switch is in the external modulation position, the internal 400 cycle modulation is turned off, and the RF signal may be modulated by feeding an audio frequency signal into the modulation jack. Approximately 3 volts is required for 30% modulation. The EXT MOD/AF OUT control enables the user to control the level of external modulation and also the level of the 400 cycle output. This control also turns the instrument off and on.

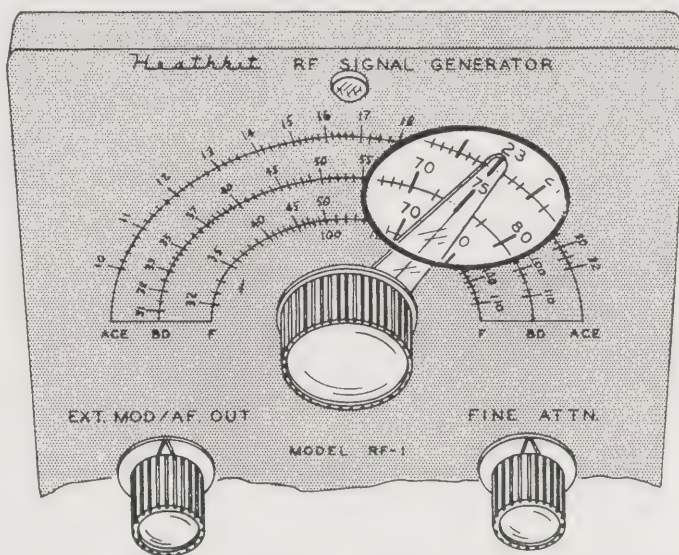


Figure 13

ALIGNMENT OF AM TUNERS AND RECEIVERS

Today's modern AM radios have become quite standardized; therefore, it is seldom necessary to refer to a specific manufacturer's alignment instructions. The most important thing to note is the IF frequency used. 455 kc is by far the most common; however, 262 kc and 460 kc are used occasionally. The following Step-By-Step Procedure can be used in most cases.

The schematic diagram of Figure 14 illustrates a typical AM receiver; the following alignment procedure would be applicable.

1. () Turn both the signal generator and the receiver on and allow several minutes for both to reach normal operating temperature.
2. () While the speaker may be used as an indication of output, it is much more desirable to use some other type of output indicator. This may be an AC voltmeter, connected directly across the speaker voice coil or perhaps a VTVM, connected to measure AVC voltage, would be more desirable.

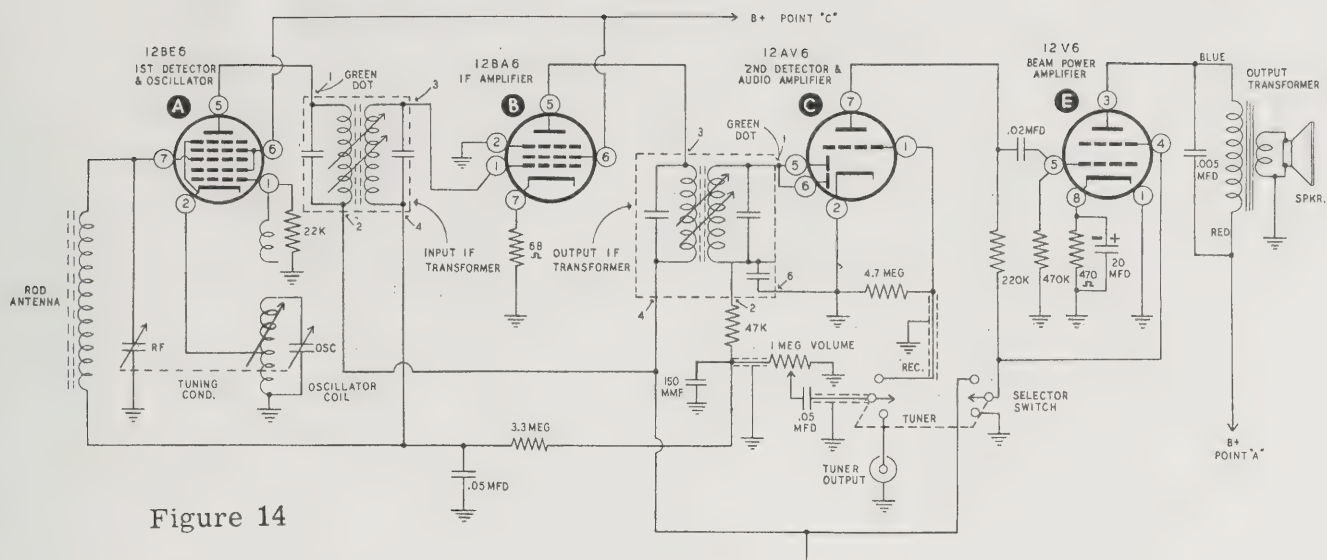


Figure 14

3. () Turn the receiver dial so that the tuning capacitors are completely open (high frequency end of dial).
4. () Couple the signal generator to the receiver antenna. The most convenient method of accomplishing this is to place the "hot" lead of the generator output cable in close proximity to the loop or rod antenna. In some extreme cases it may be necessary to connect directly to the antenna terminals or the IF grid. Set the generator to the IF frequency (455 kc) and set the modulation switch to INT MOD.
5. () Adjust the output of the signal generator to the point where the signal can just be heard, or read on the output indicator.
6. () Adjust the IF transformers for maximum output. Keep reducing the signal generator output as necessary to keep a low reading on the output indicator. Repeat these adjustments at least once to correct for any interaction between primary and secondary windings of the individual transformers. Interaction is most likely to occur in sets where adjustment is by means of iron core slugs rather than trimmer capacitors.
7. () Next, tune the receiver to its highest calibrated frequency setting (usually somewhere around 1600 kc). Set the generator to the same frequency and adjust the oscillator trimmer for maximum output.
8. () Now tune the receiver and signal generator to 1400 kc and adjust the RF trimmer for maximum output.
9. () Set the signal generator to 600 kc and tune the receiver to the low frequency end of the dial. Now "rock" (turn slightly back and forth) the receiver tuning capacitor while at the same time adjusting the oscillator trimmer (or slug) for maximum output. In some receivers, the low frequency oscillator adjustment will be made by means of an iron core slug in the oscillator coil rather than by a trimmer. On receivers that have no low end oscillator adjustment, it may be necessary to compromise between the high and low end tracking.
10. () Step 8 should be repeated if it was found necessary to readjust the trimmer, or slug, as directed in Step 9.

The RF alignment procedure for multiband AM receivers is essentially the same as outlined above for a single band set. Each band is aligned separately, starting with the highest frequency and working toward the lowest. The technique outlined above should be used but with appropriate high and low frequency settings for each band.

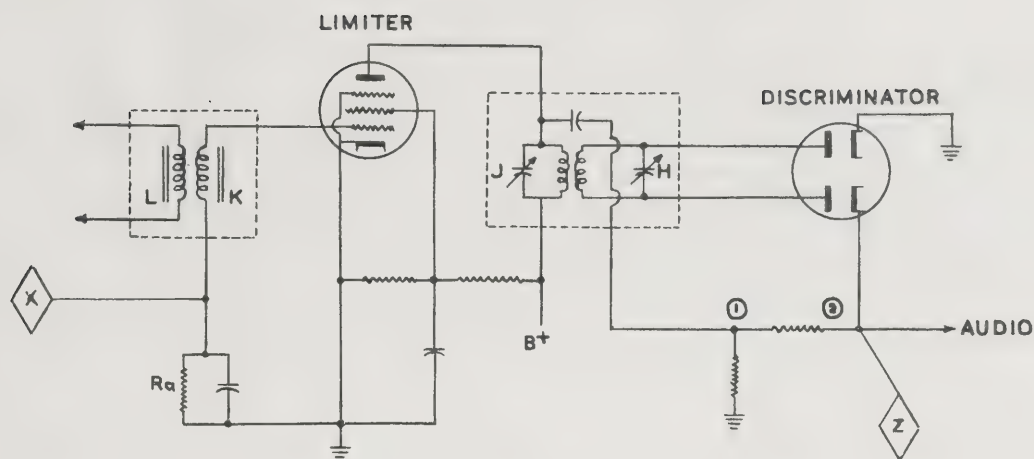


Figure 15

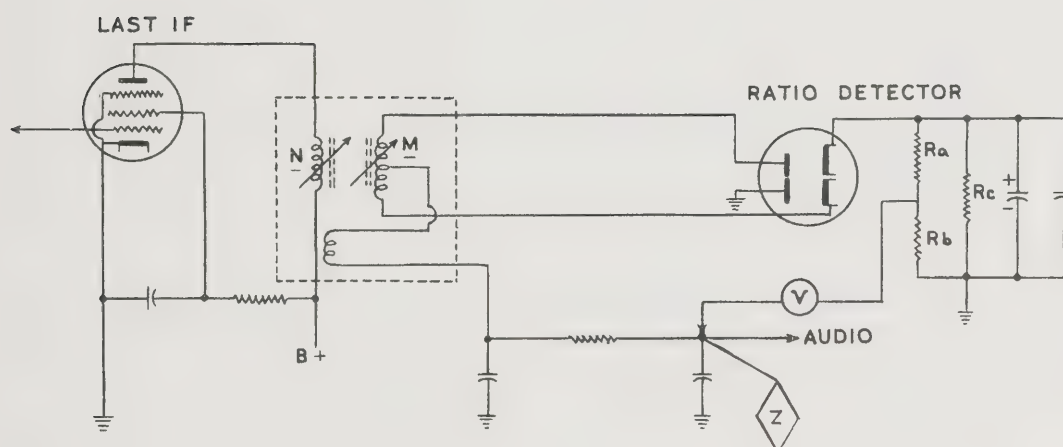
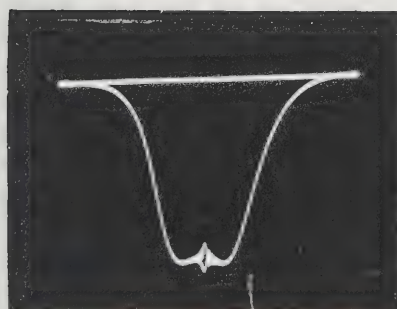
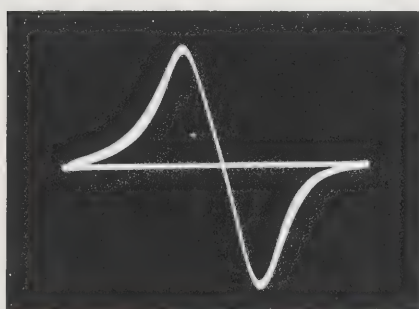


Figure 16



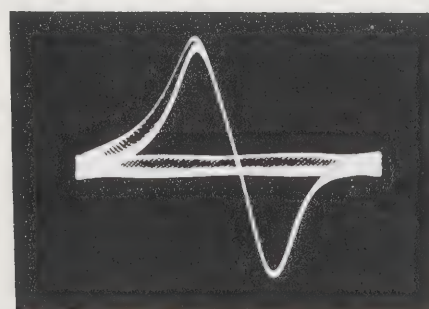
17A

FM IF response with 10.7 mc marker.



17B

Ratio detector or discriminator response with 10.7 mc marker at 0.



17C

Ratio detector or discriminator response with 10.7 mc marker not at 0. Note 400 cycle modulation.

FM TUNER AND RECEIVER ALIGNMENT

While the procedure of aligning the IF, and then the oscillator and RF, of an FM receiver is similar to that of an AM receiver, there are several important differences, the greatest one being that the ratio detector or discriminator must be aligned after the IF alignment. Due to the many varied IF bandwidths and types of IF transformer coupling that are used, it is imperative that the unskilled operator consult the receiver manufacturer's alignment notes before attempting FM alignment. While many FM receivers may be aligned with a standard AM generator by peaking the IF's to the IF frequency (usually 10.7 mc), as many others will have to be aligned using a sweep generator. Therefore, only a general procedure will be outlined here. The RF-1 may be used, no matter which procedure is recommended by the manufacturer, either as an AM generator or as an accurate marker generator during sweep alignment.

Most procedures call for the use of either a vacuum tube voltmeter or oscilloscope as an output indicator. The specified indicator is generally connected in series with an approximately 100 K Ω resistor to the grid return of the last limiter (point X in Figure 15). Output indications for both RF and IF alignment are obtained from this point. Oscilloscope connections for both a ratio detector and a discriminator are shown as point Z in accompanying Figures 15 and 16, respectively. When aligning the secondary of a ratio detector or discriminator, it is sometimes very difficult to see the 10.7 marker on the S curve because the 10.7 mc point is at 0, or the crossover point. To facilitate alignment of the secondary, it is helpful to turn the modulation from the RF generator on and adjust the secondary for a minimum amount of 400 cycle signal on the S curve (see Figures 17B and 17C). A ratio detector or discriminator inherently has a certain amount of AM suppression. Therefore, when the 400 cycle AM modulation is at a minimum, the operator can be sure that the 10.7 marker is at 0 even though it may not be visible. This procedure is only effective when an AM signal generator such as the RF-1, which has very little incidental FM, is used.

Signal generator connections to the receiver vary with different procedures. Some procedures align each stage successively, starting with the last limiter stage and proceeding toward the mixer; in other procedures, the generator is connected directly to the mixer. A convenient method that can be used to connect the generator to the mixer stage without upsetting alignment is to connect the "hot" lead of the generator to an ungrounded tube shield over the mixer tube. For RF alignment, the generator is usually connected to the antenna terminals through a suitable matching pad.

SERVICING BY SIGNAL INJECTION

Another use of the generator is a method of servicing called signal injection. This procedure may prove very helpful in isolating defective stages in a receiver when other troubleshooting methods fail. The method involves the application of first, an audio signal to the grid of the audio output tube, and then moving forward to the first audio amplifier. From there an audio modulated IF frequency signal should be fed into the grid of the last IF tube. Continue to move the signal injection point toward the antenna terminals (using the appropriate frequency) until the defective stage is located; this of course would be where there is no signal heard through the receiver. For example, if a clear tone is heard when the "hot" generator lead is touched to point E in Figure 18, but not when it is touched to point F, we are reasonably sure that capacitor C1 is open. The accompanying Block Diagram may also help to illustrate this procedure. See Figure 19.

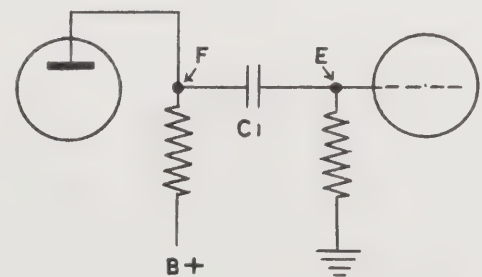


Figure 18

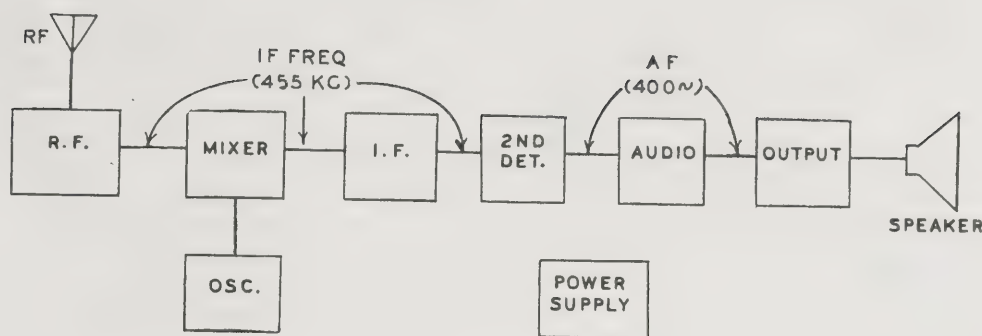


Figure 19

WARRANTY

Heath Company warrants that for a period of three months from the date of shipment, all Heathkit parts shall be free of defects in materials and workmanship under normal use and service and that in fulfillment of any breach of such warranty, Heath Company shall replace such defective parts upon the return of the same to its factory. The foregoing warranty shall apply only to the original buyer, and is and shall be in lieu of all other warranties, whether express or implied and of all other obligations or liabilities on the part of Heath Company and in no event shall Heath Company be liable for any anticipated profits, consequential damages, loss of time or other losses incurred by the buyer in connection with the purchase, assembly or operation of Heathkits or components thereof. No replacement shall be made of parts damaged by the buyer in the course of handling or assembling Heathkit equipment.

NOTE: The foregoing warranty is completely void and we will not replace, repair or service instruments or parts thereof in which acid core solder or paste fluxes have been used.

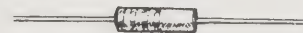
HEATH COMPANY

PARTS LIST

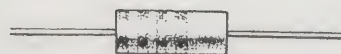
PART No.	PARTS Per Kit	DESCRIPTION
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Resistors

1-1	2	47 Ω 1/2 watt (yellow-violet-black)
1-7	3	680 Ω 1/2 watt (blue-gray-brown)
1-20	1	10 K Ω 1/2 watt (brown-black-orange)
1-24	3	33 K Ω 1/2 watt (orange-orange-orange)
1-26	3	100 K Ω 1/2 watt (brown-black-yellow)
1-47	1	56 K Ω 1/2 watt (green-blue-orange)
1-48	1	390 Ω 1/2 watt (orange-white-brown)
1A-23	1	2.2 K Ω 1 watt (red-red-red)



1/2 Watt Resistor

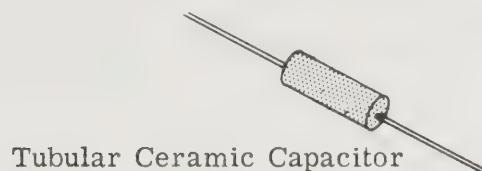


1 Watt Resistor

PART No.	PARTS Per Kit	DESCRIPTION
Capacitors		
20-99	1	22 $\mu\mu\text{f}$ mica
20-101	1	47 $\mu\mu\text{f}$ mica
21-14	2	.001 μfd disc ceramic
21-16	4	.01 μfd ceramic
21-27	1	.005 μfd ceramic
21-29	1	4.7 $\mu\mu\text{f}$ N750 tubular ceramic
21-31	5	.02 μfd disc ceramic
21-32	1	47 $\mu\mu\text{f}$ disc ceramic
21-50	1	2.2 $\mu\mu\text{f}$ small molded phenolic
23-28	1	.1 μfd 200 V tubular
23-39	1	.0047 μfd 600 V tubular
23-50	1	.022 μfd 400 V tubular
23-59	1	.05 μfd 200 V tubular
25-7	1	20-20 at 150 V electrolytic
26-57	1	164 $\mu\mu\text{f}$ and 364 $\mu\mu\text{f}$ tuning (dual)
31-8	1	1-10 $\mu\mu\text{f}$ trimmer



Ceramic Disc Capacitor



Tubular Ceramic Capacitor



Small Molded Phenolic



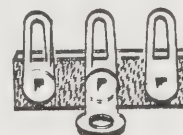
Tubular Capacitor

Controls-Transformers-Switches

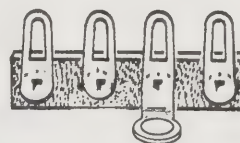
A-19-11	1	100 K Ω control w/switch
B-10-27	1	3 K Ω audio taper control
51-44	1	Oscillator transformer
54-92	1	Power transformer
63-70	1	3-position attenuator switch
63-211	1	2-position modulation switch
163-2	1	Band switch and coil assembly

Consisting of:

20-52	1	7.5 $\mu\mu\text{f}$ mica capacitor
40-188	1	Band A oscillator coil
40-189	1	Band B oscillator coil
40-190	1	Band C oscillator coil
40-191	1	Band D oscillator coil
40-192	1	Band E oscillator coil
63-212	1	6-position band switch



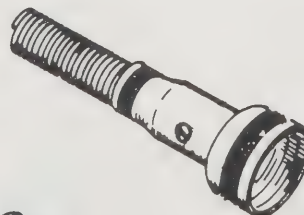
3-lug Terminal Strip



4-lug Terminal Strip

Terminal Strips-Connectors-Sockets

431-10	2	3-lug terminal strip
431-40	3	4-lug terminal strip
432-1	1	Cable connector
432-3	2	Chassis connector
434-77	2	9-pin wafer tube socket
434-87	1	Pilot light socket



Cable Connector



Chassis Connector

Tubes-Lamps

411-24	1	12AT7 tube
411-68	1	6AN8 tube
412-1	1	#47 pilot lamp
413-4	1	Pilot light jewel with nut

PART No.	PARTS Per Kit	DESCRIPTION
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Wire-Cable-Sleeving

340-2	1	Length #20 bare wire
343-2	1	Length coax cable
344-1	1	Length hookup wire
346-1	1	Length sleeving
347-3	1	Length 2-conductor shielded cable



6-32 RHMS



8-32 Setscrew



#10 Sheet Metal Screw



3-48 BHMS

Metal Parts

90-110	1	Cabinet
100-M10	1	Dial pointer assembly
200-M221	1	Chassis
203-180F273	1	Front panel



6-32 BHMS



3-48 Nut



6-32 Nut

Hardware

250-7	5	6-32 x 3/16" RHMS
250-16	1	8-32 setscrew
250-49	4	3-48 x 1/4" BHMS
250-56	13	6-32 x 1/4" BHMS
250-83	2	#10 sheet metal screw
250-89	4	6-32 x 3/8" BHMS
252-1	4	3-48 nut
252-3	15	6-32 nut
252-7	5	3/8" control nut
252-22	2	Speednut
253-10	5	Control flat washer
254-1	18	#6 lockwasher
254-4	7	Control lockwasher
259-1	7	#6 solder lug
259-10	2	Control solder lug
260-1	2	Alligator clip



Control Nut



Speednut



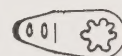
Control Flat Washer



#6 Lockwasher



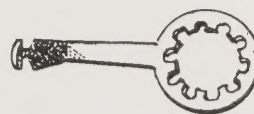
Control Lockwasher



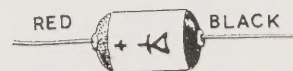
#6 Solder Lug

Miscellaneous

40-193	1	Band F oscillator coil
57-23	1	200 ma silicon rectifier
73-1	5	3/8" rubber grommet
75-24	1	Line cord strain relief
89-1	1	Line cord
207-4	2	1/4" plastic clamp
211-4	1	Handle
462-19	5	Knob, pointer
462-44	1	Knob, large
490-1	1	Alignment tool
595-274	1	Manual



Control Solder Lug



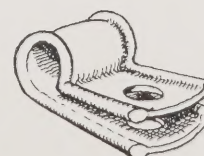
Silicon Rectifier



Line Cord Strain Relief



Rubber Grommet



Cable Clamp

Smead®
UPC 10332
No. 153L-2
HASTINGS, MIN



